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[Continued on next page]

(54) Title: FACE RECOGNITION WITH COMBINED PCA-BASED DATASETS

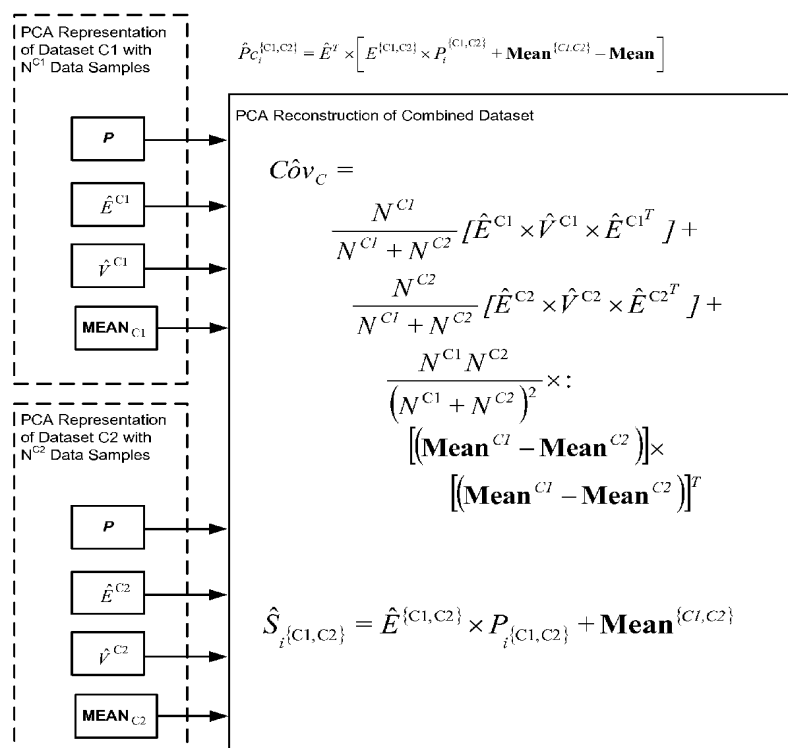


Figure 2

(57) Abstract: A face recognition method for working with two or more collections of facial images is provided. A representation framework is determined for a first collection of facial images including at least principle component analysis (PCA) features. A representation of said first collection is stored using the representation framework. A modified representation framework is determined based on statistical properties of original facial image samples of a second collection of facial images and the stored representation of the first collection. The first and second collections are combined without using original facial image samples. A representation of the combined image collection (super-collection) is stored using the modified representation framework. A representation of a current facial image, determined in terms of the modified representation framework, is compared with one or more representations of facial images of the combined collection. Based on the comparing, it is determined which, if any, of the facial images within the combined collection matches the current facial image.



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INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2007/003985

A. CLASSIFICATION OF SUBJECT MATTER
 INV. G06K9/62 G06K9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	HALL P ET AL: "Merging and Splitting Eigenspace Models" IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, IEEE SERVICE CENTER, LOS ALAMITOS, CA, US, vol. 22, no. 9, 1 September 2000 (2000-09-01), pages 1042-1049, XP008081056 ISSN: 0162-8828 cited in the application the whole document	11,28
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☒ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *G* document member of the same patent family

Date of the actual completion of the international search

6 June 2008

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INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2007/003985

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HALL P ET AL: "Adding and subtracting eigenspaces with eigenvalue decomposition and singular value decomposition" IMAGE AND VISION COMPUTING, GUILDFORD, GB, vol. 20, no. 13-14, 1 December 2002 (2002-12-01); pages 1009-1016, XP008089613 ISSN: 0262-8856 the whole document	11,28
X	HALL P ET AL: "Adding and subtracting eigenspaces" PROCEEDINGS OF THE BRITISH MACHINE VISION CONFERENCE, XX, XX, vol. 2, 16 September 1999 (1999-09-16), pages 453-462, XP008089611 cited in the application the whole document	11,28
X	B. KUSUMOPUTRO ET AL: "Development of 3D Face Databases by using Merging and Splitting Eigenspace Models" WSEAS TRANS. ON COMPUTERS, vol. 2, no. 1, 2003, pages 203-209, XP008091807 the whole document	11,28
X	LIU X ET AL: "Eigenspace updating for non-stationary process and its application to face recognition" PATTERN RECOGNITION, ELSEVIER, GB, vol. 36, no. 9, 1 September 2003 (2003-09-01), pages 1945-1959, XP004429544 ISSN: 0031-3203 the whole document	11-28
A	CORCORAN PETER ET AL: "Automated sorting of consumer image collections using face and peripheral region image classifiers" IEEE TRANSACTIONS ON CONSUMER ELECTRONICS, IEEE SERVICE CENTER, NEW YORK, NY, US, vol. 51, no. 3, 1 August 2005 (2005-08-01), pages 747-754, XP008089612 ISSN: 0098-3063 cited in the application the whole document	11,28
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INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2007/003985

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
T	<p>JAVIER MELENCHÓN ET AL: "Efficiently Downdating, Composing and Splitting Singular Value Decompositions Preserving the Mean Information" PATTERN RECOGNITION AND IMAGE ANALYSIS LECTURE NOTES IN COMPUTER SCIENCE;;LNCS, SPRINGER BERLIN HEIDELBERG, BE, vol. 4478, 1 January 1900 (1900-01-01), pages 436-443, XP019060614 ISBN: 978-3-540-72848-1 -----</p>	11,28

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 1-10,12-27,29-34

III

III.1 Equation (13) (p. 13) contains a fatal flaw (operations on incoherent entities such as subtracting a vector (mean) from a matrix, subline 2). As the final equation is not given and as the combination of PCA dataset does not belong to the common general knowledge of the skilled person, the skilled person cannot use his common knowledge to determine ovc (equation (13)) and therefore the cannot determine $\bar{E}T$ which is required for equation (14). Hence the potential invention related to equations (13) and (14) and case (ii) (p. 7, l. 15-16; p. 10, l. 10-11; p. 13, l. 2) is not disclosed in a manner sufficiently clear and complete to be carried out by a person skilled in the art, Art. 5 PCT.

III.2 Claims 1-10, 12-27, 29-34 are so unclear and unsupported (Art. 6 PCT) that they cannot be meaningfully searched and examined, Art. 17(2)(a)(ii) and 34(4)(a)(ii) PCT.

III.3 Claim 1 cannot be understood, Art. 6 PCT. For example, as cases (i) and (ii) are exclusive (p. 7, l. 11-15; 10, l. 9-11):

- step (c) is about determining the modified representation using the original samples so that it cannot be interpreted as relating to case (i) (equation (12), see also p. 10, l. 18-19) and thus must be interpreted as relating to case (ii) of the desc., which itself is not disclosed in a clear and complete manner (see III.1 supra);
- on the other hand step (d) (combining without using original samples) contradicts equation (14) of the description, so that it cannot be interpreted as related to case (ii) (but instead to case (i)), in contradiction to step (c).

III.4 In addition, the following lacks of meaning (clarity) and support, Art 6 PCT, are noted about claims 2-9 depending on claim 1.

- In claim 2, the operation related to a "third collection" is not supported by the desc. (Art. 6 PCT) which describes only how to merges two collections.
- The subject-matter of claim 6 (combining training data) contradicts step (d) of claim 1 (combining without using the original samples).
- The subject-matter of claim 7 (not using original samples of the first collection) contradicts steps (a) and (c) of claim 1 (applying PCA on facial images).
- Claims 3, 4, 5, 8 and 9 depend on claim 1 which is not comprehensible.
- Claim 10 relates to a mathematical equation which has no meaning (operations on incoherent entities such as subtracting a vector (mean) from a matrix).

III.5 The same applies to claims 18-27 as they correspond to claims 1-10.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

III.6 Claims 12-17 and 29-34, depending on independent claims 11 and 28, are unclear and unsupported, Art. 6 PCT.

III.6.1 Claims 12 and 29 (updating based on "first" eigenvectors and original eigenvalues) contradict the description, where the updating is based instead on the modified eigenvectors and eigenvalues, see desc., p. 11, l. 12-15 or equation (12). This renders as well claims 13 and 30, which depend respectively on these claims 12 and 29, as well unclear and unsupported (it is noted that all these claims depend on claims 11 and 28 which relate to case (i)).

III.6.2 Claim 14 (resp. 31) contradicts step (a) of claim 11 (res. 28) on which it depends.

III.6.3 Claims 17 and 34 relate to a meaningless equation (see III.1 supra) (and this equation belongs to the part of the desc. related to case (ii), whereas claims 11 and 8 on which these dependent claims respectively depend, relate to case (i)).

III.6.4 Regarding claims 15, 16, 32 and 33, combining collections of samples having different dimensions implies that what is stored for the collections are the original samples instead of the principal components. Hence this contradicts the claims 11 and 18 on which these claims depend. In addition, the size of a vector is not a mathematical concept. Moreover, even if the "size" of the eigenvectors was to be interpreted:

I - as their norm, then since eigenvectors have a unitary norm, the expression "re-sizing the eigenvectors" would be meaningless;
 - as their dimension, then expanding their dimension to that of the sample image would be absurd as it would not lead to any dimensionality reduction.

Hence these claims cannot be understood, art. 6 PCT.

It is also remarked that corresponding passage in the desc. (p. 12, l. 6-11) is as obscure as the claims.

VIII The following features of claims 11 and 28 are not supported and therefore not searched and examined, Art. 17(2)(a)(ii) and 34(4)(a)(ii) PCT, although the other features of these claims are searched and examined.

VIII.1 How any of the methods dealt with in the application could relate to more than two collections (see first line of the independent claims) is not disclosed and therefore not supported, Art. 6 PCT.

VIII.2 Each independent claim covers in its fourth line "including at least principle component analysis (PCA) features", however the application does not disclose how to extend eigenspace merging to other features nor is this part of the common general knowledge according to the books mentioned supra, so that "at least" is not supported.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has

FURTHER INFORMATION CONTINUED FROM PCT/SA/ 210

not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2)PCT declaration be overcome.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2007/003985

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 1-10, 12-27, 29-34
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.